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(54) Hard disk drive with reduced servo field

(57) A hard disk drive has a reduced servo field in which a Gray code (track number) is completely or partially omitted when recording a servo pattern, thus enlarging a data field reserved for a user. The hard disk drive includes one recording surface having a servo pattern with a full gray code, and the remaining recording surfaces have a servo pattern with no Gray code at all or only a portion thereof. Alternatively, the full gray code is recorded on a burst region of the servo pattern using frequency conversion. Track seek operations for reduced servo field regions are carried out by seeking the field with the Gray code and then switching heads to seek the desired track.

FIG. 6

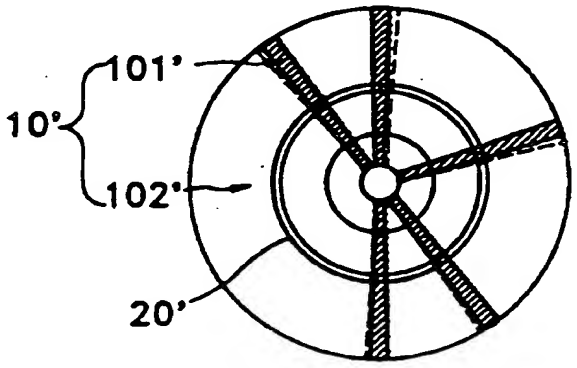

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FIG. 1A (PRIOR ART)

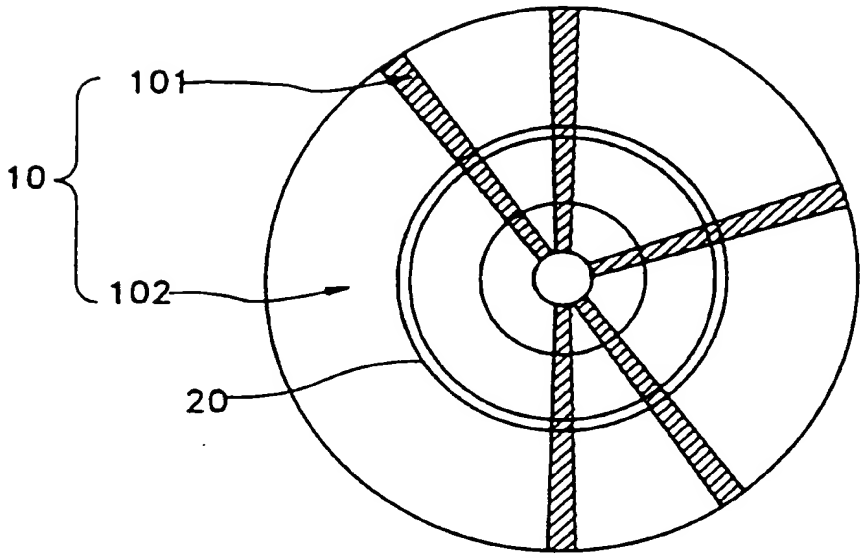


FIG. 1B (PRIOR ART)

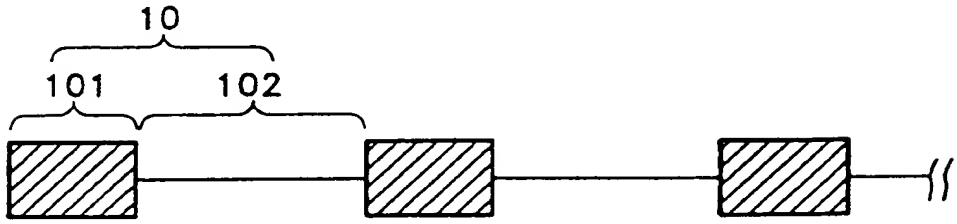


FIG. 2 (PRIOR ART)

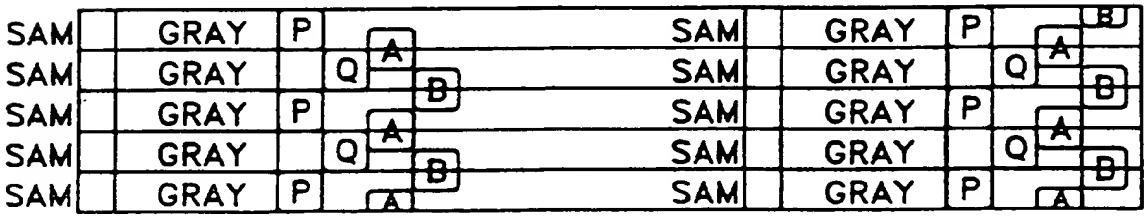
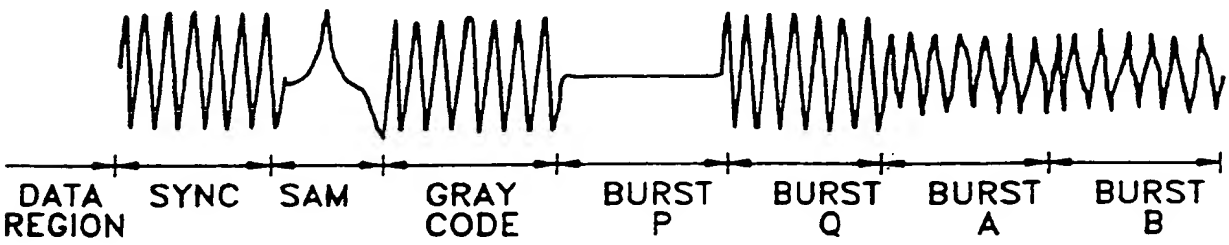


FIG. 3 (PRIOR ART)



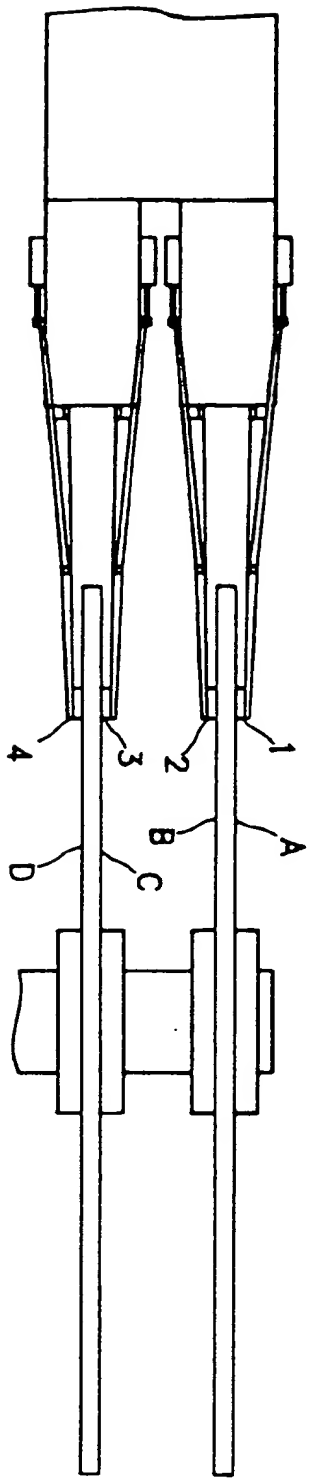


FIG. 4

FIG. 5

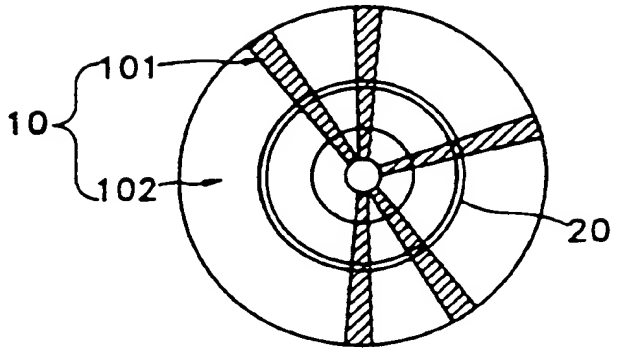


FIG. 6

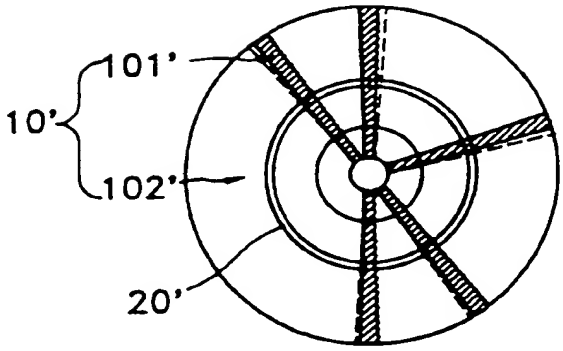


FIG. 7

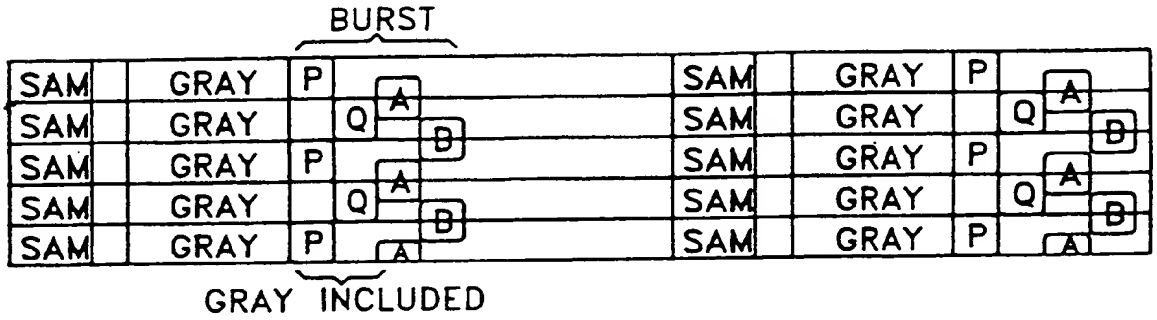


FIG. 8

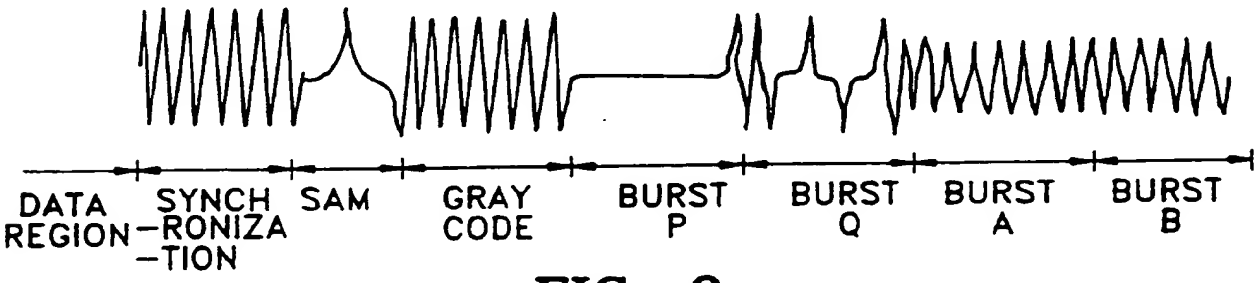


FIG. 9

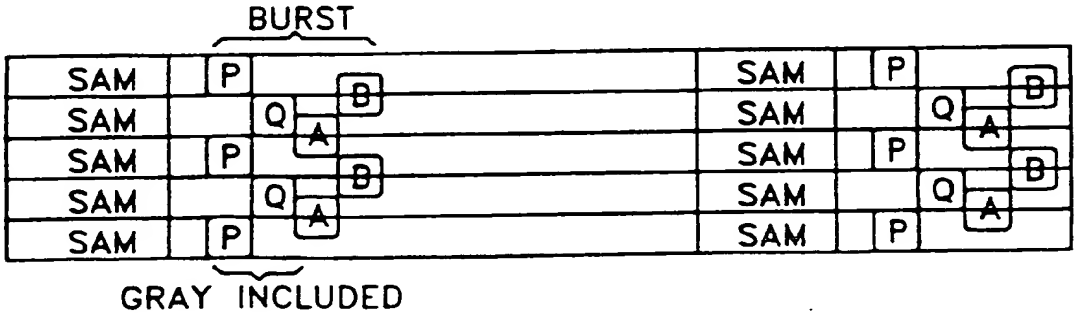


FIG. 10

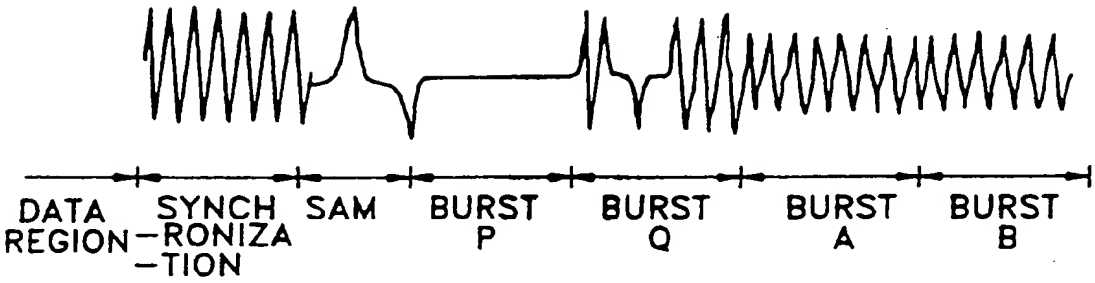


FIG. 11

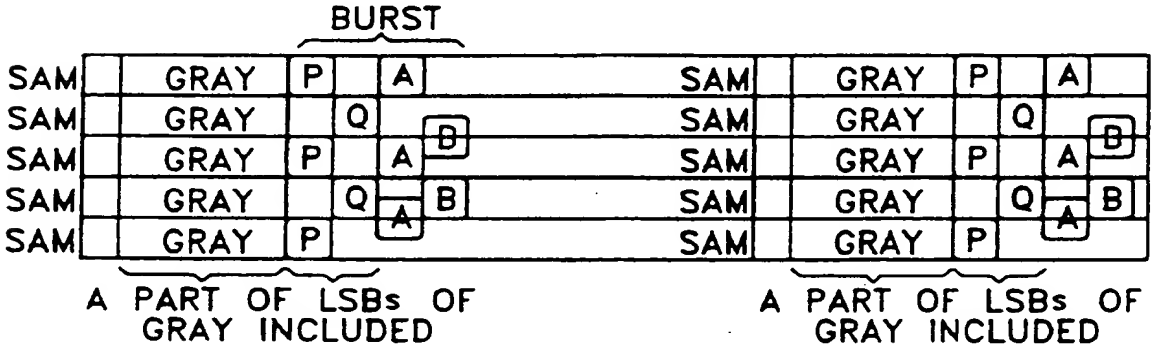


FIG. 12

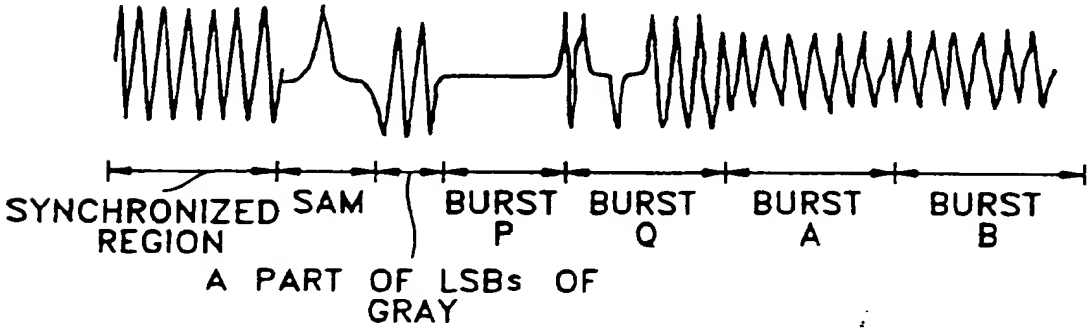


FIG. 13 (PRIOR ART)

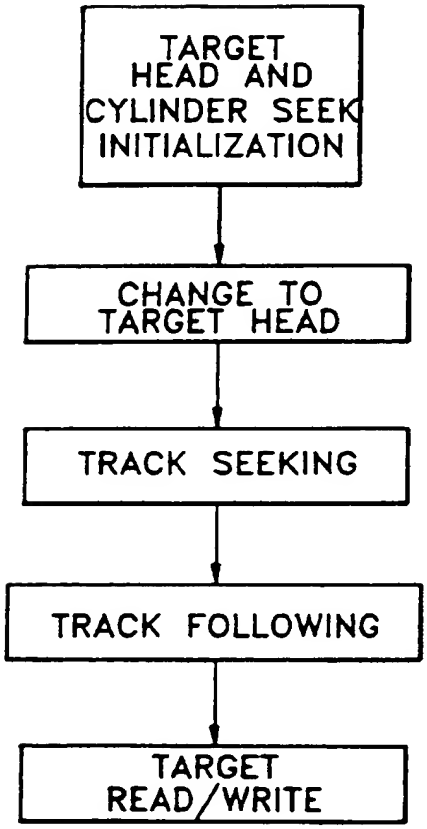


FIG. 14

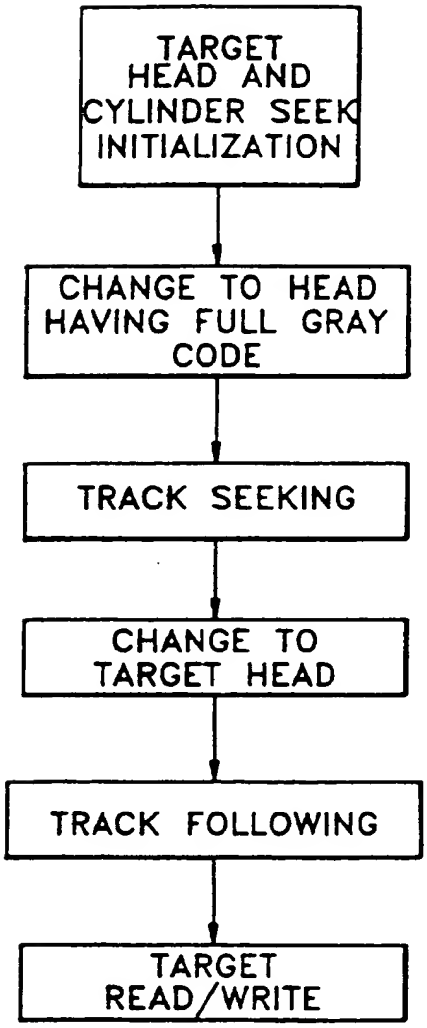


FIG. 15

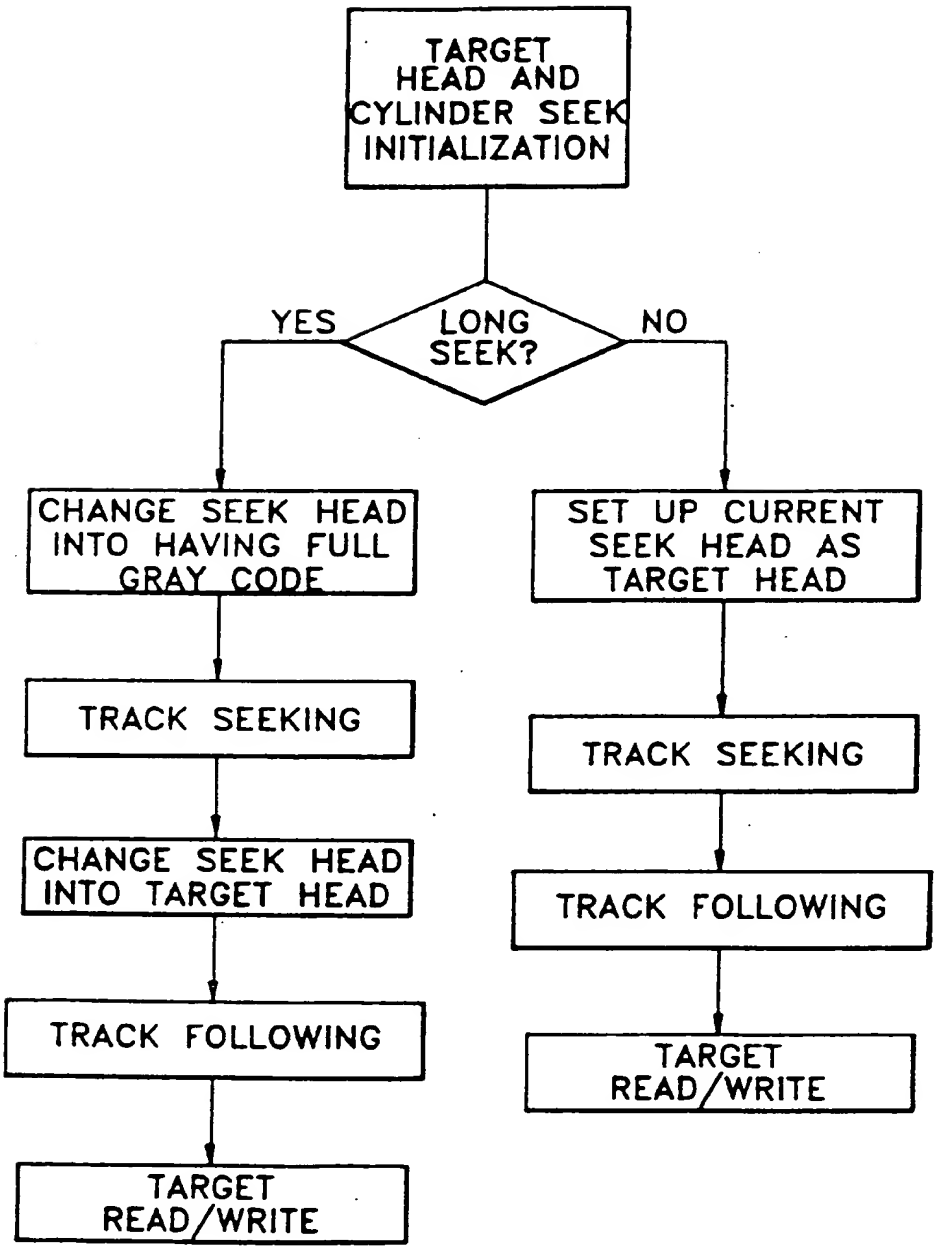

TARGET HEAD AND CYLINDER SEEK INITIALIZATION
LONG SEEK?
YES
NO
CHANGE SEEK HEAD INTO HAVING FULL GRAY CODE
TRACK SEEKING
CHANGE SEEK HEAD INTO TARGET HEAD
TRACK FOLLOWING
TARGET READ/WRITE
SET UP CURRENT SEEK HEAD AS TARGET HEAD
TRACK SEEKING
TRACK FOLLOWING
TARGET READ/WRITE

FIG. 16(PRIOR ART)

SERVO SECTOR m							DATA SECTOR	
SERVO FIELD m							ID FIELD	DATA FIELD
SYNC	SAM	IDX	GRAY-CODE	PAD	BURST	PAD	ID FIELD	DATA FIELD
4.8 μs	0.8 μs	0.8 μs	5.2 μs	0.4 μs	4.8 μs	0.4 μs	28 Bytes	542 Bytes

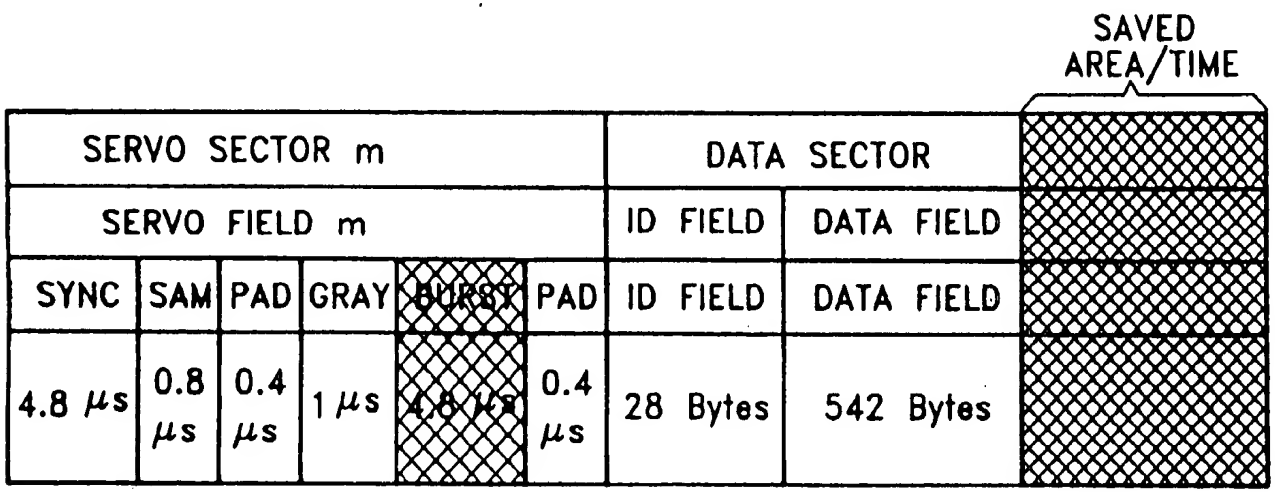
FIG. 17

SERVO SECTOR m							DATA SECTOR	
SERVO FIELD m							ID FIELD	DATA FIELD
SYNC	SAM	IDX	GRAY	PAD	BURST	PAD	ID FIELD	DATA FIELD
4.8 μs	0.8 μs	0.8 μs	5.2 μs	0.4 μs	4.8 μs	0.4 μs	28 Bytes	542 Bytes

FIG. 18

SERVO SECTOR m					DATA SECTOR		SAVED AREA/TIME
SERVO FIELD m					ID FIELD	DATA FIELD	
SYNC	SAM	PAD	BURST	PAD	ID FIELD	DATA FIELD	
4.8 μs	0.8 μs	0.4 μs	4.8 μs	0.4 μs	28 Bytes	542 Bytes	

FIG. 19


SAVED AREA/TIME
SERVO SECTOR m
DATA SECTOR
SERVO FIELD m
ID FIELD
DATA FIELD
SYNC
SAM
PAD
GRAY
BURST
PAD
ID FIELD
DATA FIELD
4.8 μs
0.8 μs
0.4 μs
1 μs
4.8 μs
0.4 μs
28 Bytes
542 Bytes

HARD DISK DRIVE WITH REDUCED SERVO FIELD AND DRIVING METHOD THEREFOR

Background of the Invention

The present invention relates to a hard disk drive with a reduced servo field and a driving method therefor, and more particularly, to a hard disk drive with a reduced servo field obtained by omitting a gray code (track number) during the recording of a servo pattern on a servo field, thereby enlarging a data sector reserved for a user (user region), and the driving method therefor.

A general hard disk drive, which is a kind of recording medium for magnetically recording information, is constituted by a read/write portion for reading a magnetic signal recorded on the disk and converting it into a corresponding digital signal, a disk controller for communicating with a main computer and controlling the system as a whole, and a servo portion for positioning a head on a specific portion of the recording surface of the disk.

Fig. 1A shows the servo sectors on a hard disk on which a servo pattern is recorded according to a conventional embedded servo method and Fig. 1B is a plan diagram of a circular track on the disk.

Also shown in Fig. 1A are tracks and sectors

which a hard disk drive reads or writes data from or to, and each track 20 and each sector 10 has its own number such as gray code or servo sector number (SSN). The sector 10 includes a servo field 101 for disk servo driving, and a data sector 102 having a data field and an ID field where a user records information.

The servo pattern, which includes servo information such as the track number or the sector number, on the servo field 101 is constituted of a SYNC, servo address mark (SAM), gray code, and burst, as shown in Fig. 2.

Here, SYNC portion is one on which a signal is recorded for more stably detecting the servo pattern when a head is moved from the data field to the servo field. The SAM is a signal used for system synchronization, that is, even if the timing of the servo pattern read by the head is shifted by the jitter of a spindle motor which rotates the disk, the servo signal synchronized with the shifted servo pattern can be read. The gray code is a header (ID) for identifying a track. The burst is a signal for determining how far the head is from the target track to be read from or written to, which is used in track following.

The servo control of the hard disk drive is

performed by track seeking which positions the read/write head on a target track using the gray code of the servo pattern to identify the track, and track following which keeps the read/write head on the target track by reading the burst of the target track, thus performing the read/write according to a user's intent. Here, keeping the read/write head on the target track is called track following.

From the above description it should be clear that the servo pattern is indispensable for controlling the read/write head. The servo pattern constituted by multiple signals, as shown by the read-back waveform diagram in Fig. 3, is recorded in the form of a digital signal. As shown by the read-back waveform of Fig. 3 which is a signal waveform detected from the servo pattern, one of a burst P and a burst Q has full amplitude and the other thereof has zero amplitude, according to odd and even track number.

As shown in FIG. 2, such a servo pattern permits the gray code to occupy a large area thereon so that the data field (sector) reserved for user information is reduced. Thus, a restructuring, e.g., a reduction of the servo field, is required to enlarge the data field.

Summary of the Invention

An object of the present invention is to provide

a hard disk drive having a reduced servo field for improving the function of a reading head to thereby secure the stability of the servo control and enlarge the data field reserved for user information by changing the way in which the servo pattern is recorded.

Another object of the present invention is to provide a driving method for the hard disk drive with a reduced servo field.

To achieve one aspect of the above object, there is provided a hard disk drive with a reduced servo field having at least one disk with at least two recording surfaces, the hard disk drive including:

at least one first surface among the recording surfaces having a servo sector with a full gray code and a data sector; and

at least one second recording surface each having a servo sector with no gray code at all and a data sector.

To achieve another aspect of the above object, there is provided a hard disk drive with a reduced servo field having at least one disk which has at least two recording surfaces, the hard disk drive including:

at least one first surface among the recording surfaces, having a servo sector with a full gray code

and a data sector; and

at least one second recording surface each having a data sector and a servo sector with only a part of the gray code.

To achieve another object of the present invention, there is provided a driving method for the hard disk drive with a reduced servo field, wherein at least one surface among at least two recording surfaces, referred to as a first recording surface, has a servo sector with a full gray code, and the remaining recording surfaces, referred to as a second recording surface, have a servo sector with no gray code at all, the driving method comprising the steps of:

cylinder seek initialization for determining a seek direction and a seek distance to find a target track on the recording surface having desired information using the servo information of a target head;

changing a seek head to the head on the first recording surface having a full gray code;

performing the track seek using the head positioned on the first recording surface having a full gray code, based on the result of the determination;

changing the seek head to a head positioned on

the target recording surface having the desired information upon completion of the track seek step; and

track following the target track using the head positioned on the target recording surface.

To further achieve another object of the present invention, there is provided a driving method for the hard disk drive with a reduced servo field, wherein at least one surface among at least two recording surfaces, referred to as a first recording surface, has a servo sector with a full gray code, and the remaining recording surfaces referred to as a second recording surface, have a servo sector with only a part of a gray code, the driving method comprising the steps of:

cylinder seek initialization for determining a seek direction and a seek distance to find a target track positioned on the recording surface having desired information using servo information of a target head;

choosing a proper seek mode between a long track seek and a short track seek on the basis of the seek distance obtained from the determination;

performing the long track seek or the short track seek according to the choice; and

track following the target track using the seek

head positioned on the target track recording surface upon completion of the track seek step.

Brief Description of the Drawings

The above objects and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings in which:

Fig. 1A is a diagram showing the servo sectors of a hard disk on which a servo pattern is recorded according to a conventional embedded servo method;

Fig. 1B is a plan diagram of a circuit track on the disk;

Fig. 2 is a diagram showing the servo pattern of the hard disk employing the embedded servo method shown in Fig. 1;

Fig. 3 is a diagram showing the read back waveform of the hard disk employing the embedded servo method shown in Fig. 1;

Fig. 4 is a vertical sectional view of a general hard disk drive;

Figs. 5 and 6 show the regions of a hard disk on which a servo pattern is recorded using an embedded servo method according to the present invention, in which

Fig. 5 shows the specific recording surface on which a servo pattern is recorded using a full gray

code;

Fig. 6 shows the reduced recording surfaces on which a servo pattern is recorded by omitting the gray code completely or partially;

Fig. 7 shows the structure of a servo pattern on a specific recording surface with a full gray code shown in Fig. 5;

Fig. 8 shows a read back waveform of a servo pattern recorded on the specific recording surface using a full gray code as shown Fig. 5;

Fig. 9 shows the structure of a servo pattern on the remaining recording surfaces having a reduced servo field with no gray code as shown in Fig. 6;

Fig. 10 shows a read back waveform of a servo pattern recorded on the remaining recording surfaces having no gray code as shown in Fig. 6;

Fig. 11 shows the structure of a servo pattern recorded on the remaining recording surfaces having only a portion of the gray code as shown in Fig. 6;

Fig. 12 shows the read back waveform of the servo pattern recorded on the remaining recording surfaces having only a portion of the gray code as shown in Fig. 6;

Fig. 13 is a flow chart showing a track seek according to the conventional hard disk servo pattern shown in Fig. 2;

Fig. 14 is a flow chart showing a track seek according to the hard disk servo pattern shown in Fig. 6, in which all the recording surfaces except for a specific recording surface have no gray code at all;

Fig. 15 is a flow chart showing a track seek according to the hard disk servo pattern shown in Fig. 6, in which all the recording surfaces except for a specific recording surface have only a portion of the gray code;

Fig. 16 shows a conventional servo pattern recorded on a recording surface shown in Fig. 2;

Fig. 17 shows an embodiment according to the servo pattern on a specific recording surface with a full gray code shown in Fig. 5;

Fig. 18 shows an embodiment according to a servo pattern on the remaining recording surfaces (excepting for the specific recording surface shown in Fig. 5) with no gray code completely shown in Fig. 6; and

Fig. 19 shows an embodiment according to a servo pattern on the remaining recording surfaces (excepting for the specific recording surface shown in Fig. 5) with only a part of the gray code shown in Fig. 6.

Detailed Description of the Invention

Fig. 4 is a sectional view of a general hard disk drive. The disk drive has two disks, each of which has recording surfaces on both the upper and lower

sides for a total of four recording surfaces A-D and four recording heads 1-4.

In the prior art, each recording surface has the same servo pattern configuration so that the area occupied by the servo field on each recording surface is the same, that is, all the recording surfaces according to the conventional embedded servo pattern have the same type of servo pattern on the same numbered track. On the other hand, in the present invention, only one recording surface among the four has the same type of servo pattern as the conventional servo pattern, as shown in Fig. 5, and the remaining three recording surfaces have no track number (gray code) or only a portion of the track number as shown in Fig. 6, so that the data field for recording user information can be enlarged.

For example, if a recording surface A of Fig. 5 has a servo pattern with a full gray code, as shown in Fig 7, each of the remaining recording surfaces B, C and D of Fig. 6 have a reduced servo field corresponding to a servo pattern with no gray code as shown in Fig 9 or with only a portion of the gray code as shown in Fig. 11.

As shown in the layout of Figs. 5 and 6, the recording surface of a hard disk is separated into sectors 10 in its circumference direction and into

tracks 20 in its radius direction, and a servo pattern is recorded on a servo field 101 which is the region where a sector 10 and a track 20 meet. The remaining recording surface includes a data field 102 where user information is recorded and an ID field.

The servo pattern, as shown in Figs. 7, 9 and 11 is constituted by a SYNC (preamble), servo address mark, gray code, burst, and the like. Here, the SYNC is used to record a regular signal for more stably detecting the servo pattern when each read/write head 1, 2, 3 or 4 is moved from the data field 102 (data sector) to the servo field 101. The SAM is used for system synchronization, that is, during a read operation, although the timing of a servo pattern is shifted by the jitter of a spindle motor during rotation of the disk, the servo information synchronized with the shifted servo pattern can be read.

There are n number of tracks, and each track has its own number. Here, the track number is recorded using a gray code, and is used to perform an address seek on a desired target track. Each track has its own servo pattern on which the track number is encoded with the corresponding gray code. Also, a track can again be separated into m number of servo sectors, on which the servo pattern is recorded and each servo

sector on the same track has the same servo pattern.

As shown in Fig. 7 the embodiment of the hard disk drive according to the present invention must have at least one specific recording surface (for example, surface A) whose servo patterns have a full gray code used for seeking a specific track on the hard disk. Such is the same as the conventional recording method of a servo pattern. A difference from the conventional method resides in the fact that the gray code is again recorded on the servo bursts P and Q using frequency conversion to obtain a signal identical to that detected during read back, as shown in Fig. 8. This is useful in determining whether the head on the target recording surface is positioned on the target track precisely or not during the step of track following. In other words, it acts as a kind of double safety device for ensuring the current position of the target recording head to improve the stability of a servo control.

A hard disk drive, according to the first embodiment of the present invention, includes a specific recording surface A and three remaining recording surfaces B, C and D. The servo pattern on each of the remaining recording surfaces has no gray code as shown in Fig. 9 and instead, a gray code is recorded on the bursts P and Q using a frequency

conversion method as shown by the signal detected during read back, as shown in Fig. 10.

In the first embodiment of the hard disk drive according to the present invention, the track seek for finding the target track is performed by a first head 1 which becomes the seek head in case the target track is on the first surface of the specific recording surface A or by one of the remaining heads 2, 3 and 4 which becomes the seek head in case the target track is on one of the remaining recording surfaces B, C, or D, and track following is performed by the seek head determined in the track seek. The seek head is an abbreviation of the target track seek head which means a head for seeking the target track on the recording surface. Here, the gray code recorded using a frequency conversion method on the bursts P and Q is used for inspecting whether the head on the target recording surface is precisely positioned on the target track or not in the same manner as described above.

A second embodiment of the hard disk drive according to the present invention includes one specific recording surface A and three remaining recording surfaces B, C and D. Here, the servo pattern on each of the remaining recording surfaces is composed of only the least significant bits (LSBs) of

the gray code, as shown in Fig. 11, and the full gray code is recorded on the bursts P and Q using frequency conversion to obtain a signal identical to that detected during read back, as shown in Fig. 10.

In the second embodiment of the hard disk drive according to the present invention, the track seek is separated into a long track seek mode and a short track seek mode.

The first head 1 on the specific recording surface A performs the track seek only in the long track seek mode when the target track is far from the current track. Also, track following during the long track seek mode is performed by the first head 1 when it is positioned on the target track of the specific recording surface A, and by one of the remaining heads 2, 3 and 4 positioned on the target track of one of the remaining surfaces B, C and D.

In the short track seek mode where the target track is near the current track, and the track seek and track following are performed at the same time by only changing the seek head, i.e., if the target track and the current seek head are positioned on the same recording surface, the current seek head retains its function as a seek head.

Here, the gray code recorded on the bursts P and Q using frequency conversion is used for determining

whether the target head is positioned on the target track precisely or not during the target track following step in the same manner as described above.

The driving methods of the first and the second embodiments of the hard disk drive according to the present invention will be described below.

First, a hard disk drive controller (not shown) performs a track seek operation for detecting the current position of the seek head positioned on a track by reading the track number from the servo pattern of the track.

Once the track seek is completed, an on-track step for positioning the seek head on the center of the detected track is performed so that a user can read or write data therethrough. Such an on-track step is the track following step for keeping the seek head on the target track detected thereby. The on-track step is controlled by detecting the quantity of off-track from the burst signal recorded on half of the track.

Consequently, the track seek is performed by reading a gray code having a track number, and track following performed after the track seek is accomplished by reading the burst signal recorded on each sector and detecting the quantity of off-track therefrom.

According to a general embedded servo pattern, all recording surfaces of a disk drive and all tracks thereon have servo patterns, and servo patterns on the same cylinder of all the recording surfaces are identical. A general read and write operation is performed according to the process as shown in Fig. 13. Such a reading and writing operation is performed in the same way as it is in the driving method of the short track seek mode of the second embodiment according to the present invention and will be described below. The only difference is that the driving method according to the present invention further includes the step of determining whether the seek head is positioned on the target track precisely or not during track following by using the full gray code recorded on the bursts P and Q using frequency conversion.

Referring to Fig. 14, according to the driving method of the first embodiment of the present invention having a reduced servo field, all the recording surfaces except for one (for example, specific recording surface A) in the hard disk drive have no gray code at all (of course, gray code is recorded with bursts P and Q).

The first step is a cylinder, which is defined as a set of tracks having the same radius on all the

recording surfaces, seek initialization step for determining the direction and distance of the target track from the current track, i.e., the track on which the current seek head is positioned.

There follows a seek head changing step for changing the current seek head to the first head 1 on the recording surface having a full gray code (for example, surface A) to perform a track seek.

There follows a track seeking step for performing track seek using the first head 1 on the surface having a full gray code (surface A) on the basis of the result from the preceding step.

There follows a seek head changing step for changing the current seek head to the head of the target recording surfaces (one head among the heads of the first, second, third and fourth recording surfaces) on the recording surface having the target track (one surface among surfaces A, B, C and D). If the target track is positioned on the specific recording surface A, having the full gray code, the current seek head on the first recording surface becomes the seek head without any change thereto and if the current seek head is not identified as the head of the target recording surface, the track seek is performed after the current seek head is changed from the current seek head to the head of the target

surface.

There follows a track following step for keeping the seek head on-track by reading the burst of the target track using the head of the target recording surface when the target track is detected. Here, the reading and writing step is performed under precise on-track conditions. In the track following step, the gray code recorded on the burst using frequency modulation of the burst signal is used for inspecting whether the seek head is positioned on the target track precisely or not and correcting the detected error.

A second embodiment of the driving method according to the present invention relates to the second embodiment of the hard disk drive having a reduced servo field. Here, all the recording surfaces of the hard disk drive except for one (for example, surface A) have the servo pattern with only a portion of the gray code, i.e., only the least significant bit of the track number (gray code).

Thus, the track seek can be performed without changing the seek head in the range detected by only the least significant bit of the track number (gray code) in the short track seek mode, thereby reducing the time for a target track seek. On the other hand the first embodiment of the driving method according

to the present invention consumes too much time because the track seek is performed after changing the seek head from the current seek head to the head which is positioned on the recording surface having a full gray code, without exception.

The second embodiment of the driving method according to the present invention will be described below in detail with reference to Fig. 15.

The read and write operations for such a hard disk are performed by selecting a proper seek mode between a long track seek and a short track seek in order to reduce a track seek time. That is, the servo pattern of a recording surface having only four LSB's of the gray code, omitting the other portion thereof, can detect 16 (2^4) tracks, in the range of which the short track seek is performed without changing the seek head.

The read and write operations of the second embodiment of the driving method according to the present invention are performed by executing the steps of cylinder seek initialization, selecting the seek mode between a long track seek and a short track seek, and following the seek steps of the first embodiment, as shown in Fig. 14 during a long track seek, which is outlined in the flow chart in Fig. 15, when the condition of the decision block is satisfied, and

following the seek steps of the conventional method, shown in Fig. 13 during a short track seek, which is outlined in the flow chart in Fig. 15, when the condition of the decision block is not satisfied.

Fig. 16 shows an example of the servo pattern on a conventional recording surface, and Fig. 17 shows an embodiment of the servo pattern according to the present invention which is recorded on the specific recording surface A having a full gray code. The only difference between the two is that a full gray code is recorded on the burst of the servo pattern using frequency conversion in the present invention.

Fig. 18 is an embodiment of the servo pattern of the present invention having no gray code at all recorded on the remaining recording surfaces B, C, and D, and Fig. 19 is an embodiment of the servo pattern according to the present invention having only a portion of the gray code recorded on the remaining recording surfaces B, C, and D. As shown in Figs. 18 and 19, the recording surfaces, except for the specific recording surface A, according to the first and second embodiments of the present invention have a reduced servo field by partially or completely omitting the gray code, thereby enlarging the data fields thereof.

As described above, the hard disk drive of the

present invention, having a reduced servo field, has a specific recording surface whose servo pattern has a full gray code, and the remaining recording surface servo patterns have no gray code at all (as the first embodiment) or only a portion thereof (as the second embodiment), thereby reducing its servo field and enlarging its data field.

Moreover, the driving method for the hard disk drive according to the present invention further includes the step of recording the full gray code in the form of the frequency conversion code on the burst region of the servo patterns of the remaining recording surfaces having no gray code at all or only a portion thereof so that track following can be performed more precisely. That is, recording the full gray code on the burst region of the servo pattern acts as a kind of double safety device for positioning the target recording head on the desired point more precisely and improving the stability of the servo control of the hard disk drive.

Especially, the driving method of the second embodiment separates the servo control into track seek using the specific head and track following using the target head, thus reducing the track seek time during the short track seek.

CLAIMS:

1. A hard disk drive with a reduced servo field having at least one disk with at least two recording surfaces, said hard disk drive comprising:

at least one first surface among said recording surfaces having a servo field with a full gray code and a data sector; and

second recording surfaces each having a servo sector with no gray code at all and a data sector.

2. A hard disk drive with a reduced servo field as claimed in claim 1, wherein said gray code is recorded on a burst of each servo sector of said first and second recording surfaces.

3. A hard disk drive with a reduced servo field as claimed in claim 2, wherein said gray code is recorded using frequency conversion of the burst signal of said burst region.

4. A hard disk drive with a reduced servo field having at least one disk which has at least two recording surfaces, said hard disk drive comprising:

at least one first surface among said recording surfaces having a servo sector with a full gray code and a data sector; and

second recording surfaces each having a data sector and a servo sector with only a part of the gray

code.

5. A hard disk drive with a reduced servo field as claimed in claim 4, wherein said gray code is recorded on a servo burst of each servo sector of said first and said second recording surfaces.

6. A hard disk drive with a reduced servo field as claimed in claim 5, wherein said gray code is recorded using frequency conversion of the burst signal of said burst region.

7. A hard disk drive with a reduced servo field as claimed in claim 4, wherein said portion of the gray code is constituted only by the least significant bits so that a short track seek within a limited number of tracks can be possible.

8. A hard disk drive with a reduced servo field as claimed in claim 5, wherein said portion of the gray code is constituted only by the least significant bits so that a short track seek within a limited number of tracks can be possible.

9. A hard disk drive with a reduced servo field as claimed in claim 6, wherein said portion of the gray code is constituted only by the least significant bits so that a short track seek within a limited number of tracks can be possible.

10. A driving method for the hard disk drive with a reduced servo field, wherein at least one

surface among at least two recording surfaces has a servo sector with a full gray code, and the remaining recording surfaces referred to as a second recording surface, have a servo sector without gray code at all, said driving method comprising the steps of:

cylinder seek initialization for determining a seek direction and a seek distance to find a target track on the recording surface having desired information using the servo information of a target head;

changing a head to said head on said first recording surface having a full gray code;

performing said track seek using said head positioned on said first recording surface having a full gray code, based on the result of said determination;

changing the seek head to a head positioned on said target recording surface having desired information upon completion of the track seek step; and

track following the target track using said head positioned on said target recording surface.

11. A driving method as claimed in claim 10, wherein said track following step further comprises the step of determining whether the seek head for said track following is positioned on said target track

precisely or not by using the full gray code recorded using frequency conversion of a burst signal recorded on the burst region of each servo sector of all said recording surfaces.

12. A driving method for the hard disk drive with a reduced servo field, wherein at least one surface among at least two recording surfaces has a servo sector with a full gray code, and the remaining recording surfaces referred to as a second recording surface, have a servo sector with only a part of gray code, said driving method comprising the steps of:

cylinder seek initialization for determining a seek direction and a seek distance to find a target track positioned on the recording surface having desired information using servo information of a target track;

choosing a proper seek mode between a long track seek and a short track seek on the basis of the seek distance obtained from said determination;

performing said long track seek or said short track seek according to said choice; and

track following the target track using the seek head positioned on said target track recording surface upon completion of said track seek step.

13. A driving method as claimed in claim 12, wherein said long track seek comprises the steps of:

changing the seek head to said recording head positioned on said first recording surface having a full gray code;

performing said track seek using said seek head positioned on said first recording surface having a full gray code based on the result from said determination; and

changing the seek head to said head positioned on said target recording surface having desired information when said track seek step is completed.

14. A driving method as claimed in claim 12, wherein said short track seek comprises the steps of:

designating a current seek head as a target track seek head, or changing said current seek head to another head as said target track seek head; and

performing said track seek using said target head.

15. A driving method as claimed in claim 12, wherein said step of track following further comprises the sub-step of confirming whether said target track seek head for said track following is positioned on said target track precisely or not by using said part of gray code recorded using frequency conversion of a burst signal recorded on the burst region.

16. A hard disk drive having one or more recording surfaces, wherein at least one said

recording surface comprises address information superimposed upon servo information.

17. A hard disk drive, comprising:

a first recording surface having at least one usable data portion and corresponding servo portion, said corresponding servo portion comprising address information;

at least one other recording surface, having an increased data portion and a reduced servo portion, said reduced servo portion comprising less address information than the servo portion of said first recording surface; and

means for deriving address information for said at least one other recording surface from said servo portion of said first recording surface.

18. A hard disk drive according to claim 17, wherein said reduced servo portion of said at least one other recording surface comprises no address information.

19. A hard disk drive according to claim 17 or 18, wherein said address information stored on said first recording surface is superimposed upon track following information.

20. A hard disk drive according to claim 17, wherein reduced address information, stored on said at least one other recording surface is superimposed upon

track following information.

21. A hard disk drive according to claim 19, wherein said address information is superimposed upon said track following information using frequency conversion of the track following signal.

22. A hard disk drive according to claim 20, wherein said reduced address information is superimposed upon said track following information using frequency conversion of the track following signal.

23. A method of locating a portion of a first recording surface of a hard disk drive, said first recording surface having incomplete address information or no address information;

said hard disk drive further comprising a second recording surface having full address information;

said first recording surface being associated with a first read/write head and said second recording surface being associated with a second read/write head, wherein said first and second read/write heads are displaceably mounted to traverse the associated recording surfaces; said method comprising the steps of:

assigning said second read/write head to be a seek head;

seeking a portion on said second recording

surface with said second read/write head, which is equivalently positioned to said portion to be located on said first recording surface and in so doing moving said first read write head to an equivalent position on said first recording surface;

assigning said first read/write head as a seek head; and

track following using said first read/write head to locate the portion to be located on said first recording surface.

24. A hard disk drive substantially as herein described with reference to any of Figs. 4 to 12, 14, 15, and 17 to 19.

The Patent Office

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Claims searched:	1 to 15, 17 to 24	**Date of search:**	6 February 1997

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G5R (RHD, RHE, RKB, RKF, RKH, RKX, RB26)

Int Cl (Ed.6): G11B 5/54, 5/55, 5/596, 21/08, 21/10, 23/36, 27/10, 27/28, 27/30, 27/32

Other: Online: WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	EP 0560282 A2 (NEC) see page 5 lines 16 to 41	1, 4, 17 and 23 at least
X	US 5459623 (BLAGAILA et al) see column 8 line 14 to column 10 line 20	1, 4, 17 and 23 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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